**Profitability and gender analysis of vegetable mono-cropping and intercropping**

1. **Introduction**

The West African Guinea/Sudan Savanna area is characterized by about 70 million small-scale, resource-poor farmers whose livelihoods depend on rain-fed crop, livestock, and crop-livestock farming systems. The weak integration of the crop and livestock enterprises as well as several interrelated technical, institutional and policy constraints in the region lead to a low productivity of the farming systems. Consequently, undernourishment, poverty, and environmental degradation are widespread. Most of projects implemented in this part of the world are focused largely on some aspects of the farming systems, such as few crop species and cropping systems, seed systems, soil fertility management, or few livestock species and husbandry systems, with little attention to the integrated management of the components of the farm, their interdependency and socio-economic impact on farm households and the natural resource base.

In response, Africa RISING project in West Africa developed a farming systems approach that aims at integrating the key components of the production systems (e.g., crop, soil/water and livestock) with household nutrition and capacity building can raise and sustain household food and nutrition security and income. Africa RISING project is one of the three regional USAID-funded Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) projects operating in Ghana and Mali under the title *'Sustainable Intensification of Key Farming Systems in the Guinea-Sudano-Sahelian Zone of West Africa'*. The project aims at providing pathways out of hunger and poverty for smallholder families through sustainably intensified farming systems that sufficiently improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. It is managed by the International Institute of Tropical Agriculture, and implemented by multi-stakeholder research-for-development platforms comprising of international and national research and development partners from the public and private sectors, community-based organizations, farmers' interest groups, service providers and market actors. In Mali, the project is implemented in 10 villages in the Bougouni-Yanfolila and Koutiala Districts of the Sikasso Region.

In the Africa RISING project Phase I (2012-2016), participatory and multi-disciplinary research resulted in implementation of baseline studies and literature reviews that generated a critical mass of data and information that is available to guide prioritization, planning, and implementation of Phase II. Climate-smart (high-yielding, early-maturing, drought and disease tolerant) crop varieties; as well as good practices to improve cereal-legume-vegetable cropping; soil fertility and water management; livestock feeding, housing, health-care and breeding management; and reduction of food waste and spoilage were identified as issues to be addressed by the project. Results were communicated in different formats, but mainly in publications, reports, and success stories, and a few technologies were taken to pilot scale for uptake and adoption. Individual and institutional capacities for SI and integrated crop-livestock research were strengthened. Africa RISING project Phase II proposes to build its continuity on the solid research partnership foundation but also on harmonized activities across countries along common research and development outcomes. The project will strengthen strategic partnerships with development institutions, and leverage on their entrepreneurial approach for success in taking technologies to scale.

Africa RISING project Phase II will also explore new research areas emerging from Phase I experiences and feedback, notably, using results from farming systems analyses and farm types to inform research targeting and technology dissemination; post-harvest management and value addition; nutrition sensitive agriculture; labour-saving mechanization solutions for small-scale farmers; focusing attention on climate-smart solutions and the effect of agricultural practices on ecosystems health. The project will also develop a livestock research strategy to increase the impact of livestock-related activities, especially those on small ruminants, poultry and pigs; develop a coherent capacity building strategy for different levels – farmers and researchers; develop a nutrition strategy to harmonize nutrition-related activities with the crop and livestock activities and with national nutrition approaches; engage in purposeful inclusion of gender and youth concerns and involvement in the SI process; and develop more rigorous and quantitative approaches for measuring diffusion and early adoption of SI technologies.

Intercropping vegetables and cereals (maize) conducted in the first phase I provided good results at the agronomic level. The effect of intercropping on pests and diseases reduces the effort and inputs required for crop protection. There may be a symbiotic cohabitation between the two crops where intercropping reduces soil erosion due to optimum coverage of the soil (Zougmore et al., 2001)[[1]](#footnote-1). We noticed a number of studies compared and contrasted biological parameters. However, the economic and gender analyses were missing. This report is concerned with conducting an economic analysis taking into gender perspective on identified climate smart crop varieties and agronomic practices (intercropping and mono-cropping) conducted by the World Vegetable center under the project in Mali. The analysis will involve women who apply agronomic practices in their own fields, and a gender comparative analysis will be carried out in terms of grain yields and cash income.

# Sample design and data analysis

The analysis uses a household survey that has been carried out in April 2017 in the project intervention areas in Bougouni and Koutiala districts. The survey involved 110 vegetables farmers with respectively 50 and 60 farmers in Koutiala and Bougouni districts. The survey involved 46 men (42%) and 64 women (58%) vegetables farmers who applied the technologies related to intercropping vegetables and cereal (maize) promoted by the project in their field (table 1 below). The survey data covered the socio-demographic characteristics of the farmers, use of inputs, production, market information and farmers’ perceptions about AR technologies.

Table 1: Distribution of farmers by district

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Farmers | **Koutiala** | | **Bougouni** | | **Total** | |
| Man | Women | Man | Women | Man | Women |
| *Tomato* | 7 | 6 | 5 | 7 | 12 | 13 |
| *Chili* | 7 | 5 | 6 | 12 | 13 | 17 |
| *Eggplant* | 2 | 9 | 6 | 8 | 8 | 17 |
| *Okra* | 8 | 6 | 5 | 11 | 13 | 17 |
| ***Total*** | **24** | **26** | **22** | **38** | **46** | **64** |

Source: constructed using survey data carried out in Bougouni and Koutiala district in April 2017.

## **Socio-demographic characteristics of farmers**

The results from table 2 below show that more than 58%% of farmers interviewed are women and 42% are men. Almost all the respondents are married but only 12% have received a formal education, most of them having a primary school level. However, we notice that 3.33% among okra farmers have received a formal education. The households size for the farmers interviewed is estimated to on average 20 members. Among the household members, about 5 per household have received a formal school. The main activity of the farmers interviewed is agriculture. On average 64% of the vegetable farmers are member of farmers’ association.

Table 2: Socio-demographic characteristics of farmers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Socio-demographic characteristics** | **Farmers interviewed** | | | | |
| Tomato | Chili | Eggplant | Okra | Average |
| Respondent sex (% woman) | 52 | 56.67 | 68.00 | 56.67 | 58.18 |
| Marital status (% married) | 96.00 | 100 | 92.00 | 100 | 97.27 |
| Respondent educated (%) | 12.00 | 16.66 | 16.00 | 3.33 | 11.82 |
| Household size | 19.72 | 25.06 | 14.88 | 20.60 | 20.31 |
| Households members educated | 4.52 | 6.93 | 4.32 | 5.00 | 5.26 |
| Main activity (% agriculture) | 100 | 100 | 96.00 | 100 | 99.09 |
| Member of farmer group (%) | 84.00 | 76.67 | 44.00 | 53.33 | 64.55 |

Source: constructed using survey data carried out in Bougouni and Koutiala district in April 2017.

## **Income from vegetables production**

This section focuses on the share of annual income derived from vegetable production in the project intervention areas. The results of the table 3 below show that more than half of the tomato farmers derive more than 75% of the annual income from tomato production both women and men. More than half of the okra women farmers derive more than 75% of their annual income from okra production. However, we notice than more than half of chili women farmers derive less than 25% of their income from chili production. On average, more than 60% of women producing vegetable derive more than 50% of their annual income from sale of the products on the market excepted for the women producing chili. The result is similar for men excepted for men producing eggplant. Overall, income from vegetable production represents an important share for the vegetable farmers both women and men in Koutiala and Bougouni districts in Sikasso region.

Table 3: Income from vegetable production

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Farm income | **Tomato** | | **Okra** | | **Chili** | | **Eggplant** | |
| Men | Women | Men | Women | Men | Women | Men | Women |
| *Less than 25%* | n.a | 33.33 | 23.08 | 29.41 | 30.77 | 58.82 | 37.50 | 17.65 |
| *Between 25% and 50%* | 16.67 | n.a | n.a | 5.88 | 7.69 | n.a | 25.00 | n.a |
| *Between 50% and 75%* | 33.33 | 16.67 | 30.77 | 11.76 | 15.38 | 17.65 | 37.50 | 35.29 |
| *More than 75%* | 50.00 | 50.00 | 46.15 | 52.94 | 46.15 | 23.53 | n.a | 47.06 |

Source: constructed using survey data carried out in Bougouni and Koutiala district in April 2017.

# Profitability analysis of intercropping versus mono-cropping

This section focuses on the comparative analysis of vegetables production with intercropping systems (vegetable – cereal) and mono-cropping in terms of yields and net benefits for tomato, okra, chili and eggplant production.

# Average yields per hectare and per technology

Table 4 below depicts the average yields per hectare for vegetables including tomato, okra, chili and eggplant. The results show that the average yields per hectare are higher for men than for women regarding the tomato and okra production. However, we notice that the average yields per hectare are higher for women than for men concerning the chili and eggplant production. Women perform better in chili and eggplant production compared to men. Men perform better in tomato and okra production (see figure 1 below). The best technology in terms of yields per hectare is intercropping 75% vegetable and 25% maize (T4) for all the four crops. The average yields per hectare for this technology is higher than the three other technologies (T1, T2, and T3). For instance, for the tomato production, T4 provides an average yields per hectare estimated to 25,966 kg/ha against 21,888 kg/ha, 3609 kg/ha, and 9836 kg/ha for T1, T2, T3 respectively.

Table 4: Average yields per hectare

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Average yields (kg/ha)** | **Vegetable production** | | | | | | | |
| Pure Vegetable | | 75% Maize and 25% Vegetable | | 50% Maize and 50% Vegetable | | 25% Maize and 75% Vegetable | |
| T1 | | T2 | | T3 | | T4 | |
| Men | Women | Men | Women | Men | Women | Men | Women |
| Tomato | 22097 | 16000 | 3706 | 2411 | 8874 | 8537 | 20742 | 24163 |
| Okra | 22413 | 15665 | 2177 | 1983 | 7954 | 7357 | 21080 | 17376 |
| Chili | 10057 | 10314 | 1122 | 1617 | 5690 | 8017 | 9299 | 21026 |
| Eggplant | 19741 | 27263 | 1046 | 3124 | 6163 | 13199 | 17286 | 33566 |

Figure 1: Average yields per hectare

# Net benefit of intercropping versus mono-cropping

This section focuses on analysis of net benefits generated by intercropping vegetable-maize compared to mono-cropping (pure vegetable) for vegetable farmers in the project intervention areas in Bougouni and Koutiala districts in Sikasso region. For the tomato production, the results from table 5 show that intercropping 75% tomato and 25% maize generates a net benefit higher than that generated by the two other intercropping (50% tomato - 50% maize, and 25% tomato – 75% maize) and pure tomato. The disaggregation per sex shows that men recorded more net benefits in pure tomato production and intercropping 50% tomato and 50% maize. However, women recorded more net benefits in intercropping 75% tomato and 25% maize, and intercropping 25% tomato and 75% maize. Overall, women perform better in intercropping that generates more net benefit namely intercropping 75% tomato and 25% maize. The results for other crops (okra, chili, and eggplant) show also that intercropping 75% vegetable and 25% maize is more economically profitable for the farmers compared to other practices.

Table 5: Net benefit per hectare for mono-cropping and intercropping tomato - maize

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Tomato production** | | | |
| Mono-cropping | 75% Maize and 25% Tomato | 50% Maize and 50% Tomato | 75% Tomato and 25% Maize |
| T1 | T2 | T3 | T4 |
| Average yields (kg/ha) | 21888 | 3609 | 9836 | 25966 |
| Sales (kg/ha) | 20827 | 3085 | 8671 | 22206 |
| Gate price (FCFA/kg) | 275 | 275 | 275 | 275 |
| ***Benefit*** | 5727357 | 779167 | 3262500 | 6131250 |
| ***Variable Costs (FCFA)*** |  |  |  |  |
| Seeds | 74241 | 3385 | 22604 | 33906 |
| Organic manure | 871429 | 108748 | 217496 | 334906 |
| Mineral fertilizers | 50278 | 17514 | 34673 | 52009 |
| Pesticides | 3750 | 1875 | 3750 | 5625 |
| Workforce | 2850 | 1382 | 2500 | 2812.5 |
| Total of variable costs (FCFA) | 986618 | 135802 | 287437 | 431156 |
| ***Net benefit (FCFA)*** | 4743911 | 648583 | 3440292 | 5734227 |
| ***Net benefit per sex (FCFA)*** |  |  |  |  |
| Men | 5509664 | 587844 | 3440292 | 5504188 |
| Women | 4054733 | 697175 | 2466850 | 6010275 |

Figure 2: Tomato production – net benefit by sex

Table 6: Net benefit per hectare for mono-cropping and intercropping okra - maize

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Okra production** | | | |
| Mono-cropping | 75% Maize and 25% Okra | 50% Maize and 50% Okra | 75% Okra and 25% Maize |
| T1 | T2 | T3 | T4 |
| Average yields (kg/ha) | 20226 | 2473 | 8972 | 23523 |
| Sales (kg/ha) | 19595 | 2347 | 7642 | 19839 |
| Gate price (FCFA/kg) | 215 | 215 | 215 | 215 |
| ***Benefit*** | 4213006 | 717025 | 2551333 | 5008828 |
| ***Variable Costs (FCFA)*** |  |  |  |  |
| Seeds | 62268 | 3721 | 18339 | 27509 |
| Organic manure | 956849 | 170387 | 340774 | 511161 |
| Mineral fertilizers | 58241 | 17599 | 35197 | 52796 |
| Pesticides | 3750 | 1875 | 3750 | 5625 |
| Workforce | 3463 | 988 | 1214 | 1821 |
| Total of variable costs (FCFA) | 1027598 | 235942 | 468982 | 703473 |
| ***Net benefit (FCFA)*** | 3206385 | 568337 | 2254000 | 4562828 |
| ***Net benefit per sex (FCFA)*** |  |  |  |  |
| Men | 4556729 | 586475 | 2000833 | 4257656 |
| Women | 2362420 | 550200 | 2507167 | 4868000 |

Figure 3: Okra production – net benefit by sex

Table 7: Net benefit per hectare for mono-cropping and intercropping Chili - maize

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Chili production** | | | |
| Mono-cropping | 75% Maize and 25% Chili | 50% Maize and 50% Chili | 75% Chili and 25% Maize |
| T1 | T2 | T3 | T4 |
| Average yields (kg/ha) | 10176 | 1276 | 7443 | 13737 |
| Sales (kg/ha) | 9012 | 1079 | 6980 | 12408 |
| Gate price (FCFA/kg) | 565 | 565 | 565 | 565 |
| ***Benefit*** | 5107561 | 819250 | 4717750 | 6292688 |
| ***Variable Costs (FCFA)*** |  |  |  |  |
| Seeds | 22096 | 3545 | 24364 | 36545 |
| Organic manure | 825192 | 118002 | 236129 | 354195 |
| Mineral fertilizers | 63958 | 19182 | 40801 | 61202 |
| Pesticides | 3750 | 1875 | 3750 | 5625 |
| Workforce | 4385 | 1148 | 1732 | 2598 |
| Total of variable costs (FCFA) | 907389 | 145398 | 308068 | 462102 |
| ***Net benefit (FCFA)*** | 4203686 | 676700 | 4432650 | 5865038 |
| ***Net benefit per sex (FCFA)*** |  |  |  |  |
| Men | 5207148 | 706667 | 4097083 | 5121563 |
| Women | 3601609 | 631750 | 4936000 | 6980250 |

Figure 4: Chili production – net benefit per sex

Table 8: Net benefit per hectare for mono-cropping and intercropping Eggplant - maize

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Eggplant production** | | | |
| Mono-cropping | 75% Maize - 25% Eggplant | 50% Maize - 50% Eggplant | 75% Eggplant - 25% Maize |
| T1 | T2 | T3 | T4 |
| Average yields (kg/ha) | 24348 | 2663 | 11197 | 29794 |
| Sales (kg/ha) | 22787 | 2121 | 10332 | 23066 |
| Gate price (FCFA/kg) | 220 | 220 | 220 | 220 |
| ***Benefit*** | 5013202 | 790625 | 3670000 | 5861250 |
| ***Variable Costs (FCFA)*** |  |  |  |  |
| Seeds | 18800 | 5104 | 38625 | 57938 |
| Organic manure | 872375 | 158550 | 220864 | 331296 |
| Mineral fertilizers | 63137 | 17965 | 35929 | 53894 |
| Pesticides | 3750 | 2632 | 5264 | 7897 |
| Workforce | 2702 | 911 | 1786 | 2678 |
| Total of variable costs (FCFA) | 905589 | 138266 | 304948 | 457422 |
| ***Net benefit (FCFA)*** | 4091189 | 659523 | 3386216 | 5435574 |
| ***Net benefit per sex (FCFA)*** |  |  |  |  |
| Men | 2583972 | 279312 | 3913625 | 6716063 |
| Women | 4786827 | 786260 | 3269014 | 5151021 |

Figure 5: Eggplant production – net benefit per sex

# Farmers’ perception about intercropping vegetable - maize

Table 9 below depicts the advantages mentioned by the vegetable farmers regarding intercropping vegetable and maize. Almost all the farmers are satisfied about intercropping strategy promoted by the Africa RISING project in its intervention areas. The farmers declared that the application of intercropping strategies particularly 75% vegetable and 25% maize increase yields per hectare. Certain tomato and chili farmers mentioned also that intercropping increase marketable surplus, and consequently increase income from vegetable production. About 40% eggplant farmers particularly women declared that intercropping strategy is adapted to climate change. A few farmers mentioned that intercropping is resistant to insect attacks.

The farmers interviewed have raised certain constraints to the application of intercropping strategy promoted by the project in their field. More than 80% of women producing tomato mentioned to have the constraints. More than 50% of women producing okra and eggplant declared also meet constraints to apply the strategy. The main constraints include unavailability of seeds (about 30% of farmers interviewed), lack of land (23% of women producing tomato, 17% of women producing okra, 12.50% of men producing eggplant, and 12% of women producing eggplant), and high cost of seeds (very few farmers). However, almost all the farmers want to continue to apply the intercropping strategy in their fields because of yield gains.

Table 9: Satisfaction about intercropping vegetable and maize

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Satisfaction about technology | **Tomato** | | **Okra** | | **Chili** | | **Eggplant** | |
| Men | Women | Men | Women | Men | Women | Men | Women |
| *Did you satisfy about technology?* | 100.00 | 91.67 | 100.00 | 100.00 | 100.00 | 94.12 | 100.00 | 100.00 |
| *Increase yields* | 100.00 | 72.73 | 92.31 | 82.35 | 84.62 | 87.50 | 87.50 | 100.00 |
| *Marketable surplus* | 33.33 | 36.36 | 0.00 | 17.65 | 23.08 | 43.75 | 0.00 | 17.65 |
| *Resistant to insects* | 8.33 | 0.00 | 0.00 | 17.65 | 0.00 | 6.25 | 0.00 | 17.65 |
| *Adapted to climate* | 25.00 | 9.09 | 30.77 | 23.53 | 15.38 | 12.50 | 62.50 | 17.65 |

Table 10: Constraints to the application of intercropping strategies

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Constraints | **Tomato** | | **Okra** | | **Chili** | | **Eggplant** | |
| Men | Women | Men | Women | Men | Women | Men | Women |
| *Have you constraints to apply?* | 41.67 | 83.33 | 38.46 | 52.94 | 46.15 | 35.29 | 37.50 | 52.94 |
| *Seeds cost* | 8.33 | 0.00 | 0.00 | 5.88 | 7.69 | 0.00 | 0.00 | 0.00 |
| *Seeds unavailability* | 25.00 | 38.46 | 38.46 | 23.53 | 23.08 | 17.65 | 25.00 | 41.18 |
| *Lack of land* | 0.00 | 23.08 | 0.00 | 17.65 | 0.00 | 0.00 | 12.50 | 11.76 |
| *Do you continue to apply?* | 100.00 | 100.00 | 100.00 | 100.00 | 92.31 | 100.00 | 100.00 | 100.00 |

# Conclusion

This report analyses the economic profitability of the application of mono-cropping and intercropping vegetable-maize by the vegetable farmers in the Africa RISING project intervention zones in Bougouni and Koutiala districts. The analysis used household survey data. The survey has been carried out in April 2017 and has involved 110 tomatoes, okra, chili, and eggplant farmers. The data were collected at household level, and gathered on socio-demographic characteristics, use of inputs, production, market information and farmers’ perceptions about AR technologies.

The results showed that the application of intercropping strategies promoted by the project in the vegetable systems production generate positive net benefits for the farmers. Intercropping 75% vegetable and 25% maize (T4) is more economically profitable compared to the three other intercropping strategies and mono-cropping. In addition, women perform better in the application of T4 in their field compared to men. Almost all the farmers are satisfied about intercropping strategy promoted by the Africa RISING project in its intervention areas. The farmers have declared that the application of intercropping strategies particularly 75% vegetable and 25% maize increase considerably yields per hectare. However, some constraints are raised by the farmers including unavailability of seeds, lack of land, and high cost of seeds. Despite of these constraints, the majority of farmers want to continue to apply the intercropping strategies promoted by the project.

In the framework of the project, it would be important to develop the strategies for facilitating the application of intercropping strategies promoted by the project. Efforts should be made for the availability of seeds and fertilizers at low price. That will contribute to improve the livelihoods of many farmers engaged in agriculture particularly in vegetable production.

1. Zougmoré, R., Kambou, N.F., Ouattara, K. and Guillobez, S. (2001). Sorghum-cowpea intercropping: an effective technique against runoff and soil erosion in the Sahel (Saria, Burkina Faso). Arid Soil Research and Rehabilitation. 14: 329-342. [↑](#footnote-ref-1)